AVIATORIAL VALVE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is a divisional application of pending U.S. Patent Application Serial No. 09/612,354, filed July 7, 2000 and entitled "Aviatorial Valve Assembly", hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] Acrobatic and mock emergency maneuvers place undue stress on the pneumatic gyroscopes within aircraft instrumentation. Most of the time, the gyroscopes in aircraft instrumentation are unaccustomed to withstanding routine acrobatic and mock emergency maneuvers. Because extremes in pitch and roll can damage the flight instruments' gimbals and bearings, common practice has been to disconnect the instrumentation's driver source prior to flight. This practice makes it impossible to return to instrument flight should nighttime or inclement weather arise prior to landing. Further, opening the instrument air system may allow airborne contaminants to harm the delicate gyroscopic instruments. Another common practice during testing and training procedures has been to simulate instrument failure, through simulated instrument conditions, by visual obstruction of the instruments. This common practice is unrealistic.

[0003] Prior attempts to lock or cage the gyroscopes still fail to prevent the excessive stress and wear on the gyroscopes' gimbals and bearings. In these attempts, mechanical devices are used to hold the gyroscopes rigid, which will not prevent damage to the gyroscopes' gimbals and bearings during acrobatic and mock emergency maneuvers.

[0004] In the non-analogous field of oil and gas, back pressure has been diverted by employing a diverter. In the non-analogous field of physical chemistry, directed at minimizing turbulence back pressure has been diverted without changing the back pressure or primary flow. But such instruments cannot fit within the standard airplane instrument panel.

[0005] Accordingly, there is a need for a device, system, and method for disengagement of the instruments in a convenient manner that will, at the same time, protect the instruments.

SUMMARY OF THE INVENTION

[0006] According to one aspect of the present invention, a unique configuration and application for a valve is provided. According to this aspect of the invention, a low-pressure valve functions over a wide range of temperature, and selectively interrupts the driver source directed to the pneumatic-gyroscopic flight instruments. The stress that instrument air sources endure is limited by preventing spikes in and maintaining the pneumatic flow, and thus, the back pressure. The valve is lightweight, easily installed, and designed to fit within a standard hole of a small airplane instrument panel.. Further, the valve interfaces with existing air and vacuum sources and other equipment within the airplane. This aspect of the present invention permits acrobatic maneuvers without disconnecting the driver source prior to flight. Moreover, the present aspect enables a remarkably rapid return to instrument flight, which safety alone warrants in the event of inclement weather or nighttime flight.

[0007] According to another aspect of the invention, a realistic simulation of instrument failure conditions during testing and training procedures is provided. Because, in this aspect, the present invention can prevent pneumatic flow to the instrument, the instrument becomes non-operational, and thereby mimics an in-flight instrument failure condition. But the ability to return to instrument flight ensures that safety is coupled to realism in producing the simulated instrument failure.

[0008] In a more specific aspect of the invention, a valve is provided for use in aircraft, the valve comprising a body, a selective interrupter positioned inside the body for rotation therein, a flow arrangement between the selective interrupter and the body, a bonnet connected to the body and in contact with the selective interrupter, an arm extending through the bonnet and connected to the selective interrupter, and an actuator movably connected to the arm.

[0009] In a further aspect of the invention, a system is provided for protecting a pneumatic-gyroscopic aircraft instrument, and a driver source drives the instrument. The system comprises a means for allowing a pneumatic flow to the instrument during flight, and a means for selectively redirecting, without interrupting, the pneumatic flow to the instrument.

[0010] In another aspect of the invention, a method is disclosed for protecting a pneumatic-gyroscopic aircraft instrument, wherein a driver source drives the instrument. The method comprises allowing a pneumatic flow to the instrument during flight, and then selectively redirecting, without interrupting, the pneumatic flow to the instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 shows a side view of one embodiment of the valve and the general shape of the valve.

[0012] Figure 2 shows a frontal view of the valve installed in an aircraft instrument panel, the tolerance of the selective interrupter in relation to the body, and the location of the lubricant, if used.

[0013] Figure 3 is a side view of the selective interrupter.

[0014] Figure 4 is a side view of the apertures in contact with the driver source, the instrument, and the dummy load.

[0015] Figure 5 is a side view of the valve where the staggered arrangement has two apertures horizontally staggered on the exterior wall of the selective interrupter, and a vertical distance between the same two apertures on the exterior wall of the selective interrupter.

[0016] Figure 6 is two side views of the horizontally staggered arrangement of the apertures on the exterior wall of the selective interrupter as viewed from each side.

[0017] Figure 7 is two side views, as viewed from each side, of the first aperture of at least three apertures where a routed band encircles the exterior wall of the selective interrupter, and the routed band includes the tops of the first apertures in its path; further shown is an aperture having a routed portion appurtenant to an aperture.

[0018] Figure 8 is two side views, as viewed from each side, of a routed portion appurtenant to the second aperture and a routed portion appurtenant to the third aperture of at least three apertures on the exterior wall of the selective interrupter.

[0019] Figure 9 is a side view of the at least three body apertures located on the outer wall of the body and the at least three body apertures in contact with the driver source, the instrument, and the dummy load.

[0020] Figure 10 is two side views of the selective interrupter inside the body, where a first aperture and the second aperture aligning with the first body aperture and the second body aperture, respectively, and the flow arrangement therein.

[0021] Figure 11 is two side views of the selective interrupter inside the body, where a first aperture and the third aperture aligning with the first body aperture and the third body aperture, respectively, and the flow arrangement therein.

[0022] Figure 12 is two side views of the selective interrupter inside the body, where the first aperture, the second aperture and the third aperture partially align with the first body aperture, the second body aperture, and the third body aperture, respectively, and the flow arrangement therein.

[0023] Figure 13 is a side view of the horizontally staggered alignment of two body apertures on the outer wall of the body, the first body aperture on the second end of the body, and the imaginary vertical plane that bisects all three body apertures.

[0024] Figure 14 is a side view of the horizontally staggered alignment of three body apertures on the outer wall of the body, and the imaginary vertical plane that bisects all three body apertures.

[0025] Figure 15 is a side view of two separated channels inside the interior of the selective interrupter, where rotary movement of the selective interrupter gradually permits the flow relationship to iteratively transition from solely within the first separated channel to solely within the second separated channel.

[0026] Figure 16 is a side view of an arm extending through the arm hole of the actuator; further, an arm connection hole and an actuator connection hole through which connecting cylinders pass in order to connect the actuator to the arm; further shown is a side view of at least a partially opened second end and a closed first end of the selective interrupter setting inside a body having a closed secondary end and an opened primary end.

[0027] Figure 17 is a side view of gearing on the arm and a geared drive shaft.

[0028] Figure 18 is a side view of connecting cylinders for connecting the actuator to the arm, the nut used to secure the connecting cylinder, a plurality of mounting cylinders connecting the bonnet to the body through the plurality of mounting holes and receptacle cylinder holes, and a raised stop for limiting the rotary movement of the actuator, and thereby, the selective interrupter.

[0029] Figure 19a is a side view of a friction member between the bonnet and the body, and two pressure pinholes that receive the pressure pin and lock the actuator into position.

[0030] Figure 1 9b shows a pressure pin extending from the actuator.

[0031] Figure 20 is a side view of the lip on the body of the valve, a plurality of installation holes on the lip, and a plurality of installation cylinders used to connect the valve into the aircraft instrument panel.

[0032] Figure 21 is a side view of a system that includes a valve, connections to a driver source and the instrument, and the pneumatic flow between the driver source and the instrument.

[0033] Figure 22 is a side view of a system where the valve is coupled to the driver source, the instrument, and a dummy load at three different body apertures, and the pneumatic flow is solely between the driver source and the instrument.

[0034] Figure 23 is a side view of a system where the valve is coupled to the driver source, the instrument, and a dummy load at three different body apertures, and the pneumatic flow is solely between the driver source and the dummy load.

[0035] Figure 24 is a side view of a system where the valve is coupled to the driver source, the instrument, and a dummy load at three different body apertures, and the pneumatic flow is between the driver source, the instrument, and a dummy load.

[0036] Figure 25 is a side view of a system where movement of the seat depends on movement of an actuator that is coupled to the seat.

[0037] Figure 26a is a side view of a system having a motor coupled to a geared drive shaft that is in contact with gearing on an arm, which together move the seat.

[0038] Figure 26b is a side view of a system having a screwed gearing drive shaft that is in contact with screwed gearing on an arm, which together move the seat.

[0039] Figure 26c is a side view of a system having a keyed gearing drive shaft that is in contact with keyed gearing on an arm, which together move the seat.

[0040] Figure 27 is a side view of a system where a stop controls the seat's degree of movement.

[0041] Figure 28a is a side view of a system where the flow arrangement is only between the driver source and the instrument.

[0042] Figure 28b is a frontal view of a system where the flow arrangement of Figure 28a is locked into position.

[0043] Figure 29a is a side view of a system where the flow arrangement is only between the driver source and the dummy load.

[0044] Figure 29b is a frontal view of a system where the flow arrangement of Figure 29a is locked into position.

DETAILED DESCRIPTION

[0045] A first aspect of invention, as seen in Figure 1, is a valve (346) for use in aircraft. One embodiment of the valve (346) includes a body (344) and a seat (342) comprising a selective interrupter (100) and an arm (102), wherein the arm (102) is connected to a first end (132) of the selective interrupter (100). The selective interrupter (100) is positioned inside the body (344) for rotation therein. A flow arrangement (110) exists between the selective interrupter (100) and the body (344). A bonnet (125) connects to the body (344) and the bonnet (125) is also in contact with the first end (132) of the selective interrupter (100). An actuator (382) is movably connected to the arm (102), and the arm (102) extends through a bonnet hole (103) in the bonnet (125).

[0046] A further embodiment, as shown in Figure 2, includes the valve (346) being installed into an aircraft instrument panel (108). A still further embodiment includes the valve (346) being installed into a standard hole within the aircraft instrument panel (108).

[0047] A further embodiment of the invention includes the valve (346) constructed of a lightweight material. The lightweight material is lighter than some instruments commonly installed in airplanes. In alternative embodiments, the lightweight material is a metal, a non-metal, a metalloid or an alloy. Non-limiting examples of a lightweight material used to construct the valve (346) are aircraft grade aluminum or nylon. In further embodiments of the invention, the valve (346) is constructed of a fire resistant material. Similarly, in alternative embodiments, the fire resistant material is a metal, a non-metal, a metalloid or an alloy. An example of a suitable fire resistant material for the valve (346) is aircraft grade aluminum. In still further embodiments, the valve (346) is constructed of an aircraft quality material in order to withstand the pressures that airplane instrumentation necessarily endure. Again, in alternative embodiments, the aircraft quality material is a metal, a non-metal, a metalloid or an alloy. A suitable example of an aircraft quality material is aircraft grade aluminum. Further still, in another embodiment of the invention, the valve (346) is constructed of a temperature-stable material such that the valve (346) functions within the temperature range of—20^0F to 212^0F. In alternative embodiments, the temperature-stable material is a metal, a non-metal, a metalloid or an alloy. A suitable example of a temperature-stable material for the valve (346) is aircraft grade aluminum.

[0048] Returning to Figure 1, a still further embodiment of the valve (346) includes the valve

(346) having a shape that is a substantially cylindrical shape. A substantially cylindrical shape makes the valve (346) easy to insert into the standard hole of an airplane instrumentation panel (108), which is a primary goal of the instant invention.

[0049] A further embodiment of the invention, as shown in Figure 2, includes the selective interrupter (100) having a minimized tolerance (123) between the selective interrupter (100) and the body (344), wherein the minimized tolerance prevents air leakage from the valve (346). As defined in this invention, the tolerance (123) is the maximum distance between the selective interrupter (100) and the body (344). If the tolerance (123) is such that the leakage of air is minimal, then no lubricant is necessary in order to use the valve (346) in an aircraft. For example, a tolerance of 0.0015 inches between the selective interrupter (100) and the body (344) is sufficiently small that no lubricant (126) is required. In still a further embodiment of the invention, the valve (346) includes a lubricant (126) between the selective interrupter (100) and the body (344). A lubricant (126) ensures easy rotation of the selective interrupter (100) and intimate contact between the selective interrupter (100) and the body (344) of the valve (346).

[0050] As seen in Figure 3, a further embodiment of the invention includes the selective interrupter (100) having an exterior wall (130), an interior (131), a first end (132), a second end (133), and at least three apertures (376a, 376b, 376c).

[0051] As seen in Figure 3, one embodiment of the invention includes the at least three apertures (376a, 376b, 376c) having at least three substantially cylindrical apertures. But further and alternative example embodiments of the invention are the at least three apertures (376a, 376b, 376c) being at least three substantially conical apertures, at least three oval slot-shaped apertures or at least three beveled apertures.

[0052] In a further embodiment of the invention, as shown in Figure 4, the at least three apertures (376a, 376b, 376c) include at least a first aperture (376a) of the at least three apertures (376a, 376b, 376c) in contact with a driver source (304), a second aperture (376b) of the at least three apertures (376a, 376b, 376c) in contact with the instrument (302), and a third aperture (376c) of the at least three apertures (376a, 376b, 376c) in contact with a dummy load (328). In still further embodiments of the invention, the dummy load (328) is a resistance dummy load such as a restrictive aperture, a pressure regulator or a vacuum regulator.

[0053] Turning to Figure 5, a further embodiment of the invention includes the at least three apertures (376a, 376b, 376c) being in a staggered arrangement (137). The further embodiment

includes the staggered arrangement (137) being a horizontally staggered arrangement (138) of the second aperture (376b) of the at least three apertures (376a, 376b, 376c) and the third aperture (376c) of the at least three apertures (376a, 376b, 376c) along the exterior wall (130). The second end (133) of the selective interrupter (100) includes the at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c).

[0054] In still a further embodiment, the horizontally staggered arrangement (138) further includes a vertical separation (142) between the second aperture (376b) of the at least three apertures (376a, 376b, 376c) and the third aperture (376c) of at least three apertures (376a, 376b, 376c). The second aperture (376b) and the third aperture (376c) are vertically positioned on the exterior wall (130) in such a way as to prevent any horizontal overlap in the horizontally staggered arrangement (138).

[0055] Turning now to Figure 6, a further embodiment of the invention is shown. The staggered arrangement (137) includes a horizontally staggered arrangement (138) of a first set (15) of two apertures of the at least three apertures (376a, 376b, 376c) and a second set (25) of two apertures of the at least three apertures (376a, 376b, 376c) on the exterior wall (130). The first set (15) includes one aperture (12) of the at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c). The first set (15) also includes the second aperture (376b) of the at least three apertures (376a, 376b, 376c). The second set (25) comprises another aperture (14) of the at least the first (376a) of the at least three apertures (376a, 376b, 376c). The second set (25) also includes the third aperture (376c) of the at least three apertures (376a, 376b, 376c).

[0056] In a further embodiment of the invention, as shown in Figure 7, the selective interrupter (100) further includes at least one routed portion (150) that forms a depression (152) in the exterior wall (130) of the selective interrupter (100). In a still further embodiment, the depression (152) in the exterior wall (130) is graduated, and forms at least one graduated routed portion.

[0057] In a further embodiment of the invention, the at least one routed portion (150) includes a routed band (157) that is in contact with the one aperture (12) of the at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c) and the another aperture (14) of the at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c). The routed band (157) encircles the exterior wall (130) of the selective interrupter (100). In a still further embodiment, as shown in Figure 8, the at least one routed portion (150) includes a first routed

portion (158) and a second routed portion (160). The first routed portion (158) is appurtenant to the second aperture (376b) of the at least three apertures (376a, 376b, 376c) and the second routed portion (160) is appurtenant to the third aperture (376c) of the at least three apertures (376a, 376b, 376c). In this manner, rotation of the selective interrupter (100) results in a gradual transition in the flow relationship (110). That is to say that there is a gradual transition in the flow relationship (110) from driver source (304) and dummy load (328) to driver source (304) and instrument (302) or vice versa.

[0058] In a further embodiment of the invention, as shown in Figure 9, the body (344) includes an outer wall (170), an inner wall (172), a primary end (174), a secondary end (176), and at least three body apertures (378a, 378b, 378c). Although Figure 9 shows the at least three body apertures (378a, 378b, 378c) having substantially cylindrical shapes, the shapes can vary. For example, in further and alternative embodiments of the invention, the at least three body apertures (378a, 378b, 378c) are substantially cylindrical body apertures, substantially oval-slot shaped body apertures or threaded body apertures.

[0059] Also shown in Figure 9 is a further embodiment, where the at least three body apertures (378a, 378b, 378c) include at least a first body aperture (378a) of the at least three body apertures (378a, 378b, 378c) in contact with the driver source (304), a second body aperture (378b) of the at least three body apertures (378a, 378b, 378c) in contact with the instrument (302), and a third body aperture (378c) of the at least three body apertures (378a, 378b, 378c) in contact with a dummy load (328).

[0060] In a still further embodiment of the invention, as shown in Figure 10, the at least three apertures (376a, 376b, 376c) and the at least three body apertures (378a, 378b, 378c) are positioned for a flow arrangement (110). The at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c) is in a complete alignment (600) with the at least the first body aperture (378a) of the at least three body apertures (378a, 378b, 378c). Further, the second aperture (376b) of the at least three apertures (376a, 376b, 376c) is in a complete alignment (600) with the second body aperture (378b) of the at least three body apertures (378a, 378b, 378c). The third aperture (376c) of the at least three apertures (376a, 376b, 376c) is completely misaligned with the third body aperture (378c) of the at least three body apertures (378a, 378b, 378c). Therefore, the flow relationship (110) exists between the first aperture (376a) and the first body aperture (378a) and the second aperture (376b) and the second body aperture (378b).

[0061] In an alternative and further embodiment, as shown in Figure 11, the at least three apertures (376a, 376b, 376c) and the at least three body apertures (378a, 378b, 378c) are positioned for the flow arrangement (110). The at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c) is in a complete alignment (600) with the at least the first body aperture (378a) of the at least three body apertures (378a, 378b, 378c). Further, the third aperture (376c) of the at least three apertures (376a, 376b, 376c) is in a complete alignment (600) with the third body aperture (378c) of the at least three body apertures (378a, 378b, 378c). But the second aperture (376b) of the at least three apertures (376a, 376b, 376c) is completely misaligned with the second body aperture (378b) of the at least three body apertures (378a, 378b, 378c). Therefore, the flow relationship (110) exists between the first aperture (376a) and the first body aperture (378a) and the third aperture (376c) and the third body aperture (378c).

[0062] In a still further and alternative embodiment, as shown in Figure 12, the at least three apertures (376a, 376b, 376c) and the at least three body apertures (378a, 378b, 378c) are positioned for the flow arrangement (110). The at least the first aperture (376a) of the at least three apertures (376a, 376b, 376c) is in a partial alignment (650) with the at least the first body aperture (378a) of the at least three body apertures (378a, 378b, 378c). Further, the second aperture (376b) of the at least three apertures (376a, 376b, 376c) is in a partial alignment (650) with the second body aperture (378b) of the at least three body apertures (378a, 378b, 378c). Further still, the third aperture (376c) of the at least three apertures (376a, 376b, 376c) is in a partial alignment (650) with the third body aperture (378c) of the at least three body apertures (378a, 378b, 378c). Therefore, the flow relationship (110) is between all of the at least three apertures (376a, 376b, 376c) and the at least three body apertures (378a, 378b, 378c).

[0063] In a further embodiment of the invention, as shown in Figure 13, the at least three body apertures (378a, 378b, 378c) include a horizontally staggered arrangement (180). The horizontally staggered arrangement (180) includes the second body aperture (378b) and the third body aperture (378c) of the at least three body apertures (378a, 378b, 378c) on the outer wall (170), and the secondary end (176) comprising the at least the first body aperture (378a) of the at least three body apertures (378a, 378b, 378c). Further, the at least three body apertures (378a, 378b, 378c) are positioned such that a vertical plane (750) bisects the at least three body apertures (378a, 378b, 378c).

[0064] In a further embodiment, the outer wall (170) further includes a raised block (411). The

second body aperture (378b) and the third body aperture (378c) of the at least three body apertures (378a, 378b, 378c) are within the raised block (411). Further still, the raised block (411) is integrally connected to the outer wall (170). A non-limiting example of the integral connection is welding the raised block (411) to the outer wall (170).

[0065] As seen in Figure 14, a further embodiment of the invention includes a horizontally staggered arrangement (180) of the at least three body apertures (378a, 378b, 378c) on the outer wall (170), wherein the at least three body apertures (378a, 378b, 378c) are positioned such that a vertical plane (750) bisects the at least three body apertures (378a, 378b, 378c).

[0066] In a further embodiment of the invention, as seen in Figure 15, the interior (131) of the selective interrupter (100) is a hollow cavity (184) that is open at the second end (133) of the selective interrupter (100). As such, in some embodiments, the second end (133) is the first aperture (376a) of the at least three apertures (376a, 376b, 376c).

[0067] In a still further embodiment of the invention, the interior (131) includes at least two separated channels (188a, 188b) within the interior (131) of the selective interrupter (100). A further embodiment, as shown in Figure 15, includes the at least two separated channels (188a, 188b) being a first separated channel (188a) and a second separated channel (188b). In this embodiment, each of the at least two separated channels (188a, 188b) are positioned between the first end (132) and the second end (133). Further, the at least two separated channels (188a, 188b) are positioned such that rotary movement (688) of the selective interrupter (100) gradually permits the flow relationship (110) to iteratively transition from solely within the first separated channel (188a) to solely within the second separated channel (188b).

[0068] In a further embodiment of the invention, the at least two separated channels (188a, 188b) are at least two substantially cylindrical channels. But in further and alternative embodiments, the at least two separated channels (188a, 188b) are substantially conical channels or threaded channels. Other shapes and arrangements of the channels will occur to those of ordinary skill in the art, but these other shapes and arrangements do not depart from the scope of the present invention.

[0069] As shown in Figure 16, a further embodiment of the invention includes the first end (132) of the selective interrupter (100) being a closed end (192). In another embodiment of the invention, the second end (133) of the second interrupter (100) is at least a partially open end (194). In still a further embodiment, the primary end (174) of the body (344) comprises an open

end (781), and the secondary end (176) of the body (344) comprises a closed end (782).

[0070] Also shown in Figure 16, the arm (102) has a substantially cylindrical shape, which is a further embodiment of the invention. The arm (102) is connected to the actuator (382). A further embodiment is a handle (7) connected to the actuator (382).

[0071] As shown in Figure 17, a further embodiment of the invention includes the arm (102) having gearing (198), which in alternative embodiments is keyed gearing, screwed gearing, or any other type of gearing occurring to those of ordinary skill in the art. In a still further embodiment of the invention, the actuator (382) includes a geared drive shaft (199) in mesh with the gearing (198).

[0072] A further embodiment of the invention includes the actuator (382) having a motor that is connected to a drive shaft. The motor provides the power to move the drive shaft, which moves the actuator (382), which in turn, moves the selective interrupter (100). In a further and alternative embodiment of the invention, the actuator (382) includes a solenoid (4), which transforms its electrical energy into mechanical energy, and thereby actuates the selective interrupter (100).

[0073] Returning to Figure 16, a further embodiment of the invention includes the actuator (382) having an ann hole (103) that is positioned to at least partially receive the arm (102). In a still further embodiment, the arm (102) includes an arm connection hole (99). In a still further embodiment, the actuator includes an actuator connection hole (97). Moreover, as shown in Figure 18, a further embodiment of the invention includes connecting cylinders (94) for connecting the actuator (382) to the arm (102).

[0074] In a further and alternative embodiments, the connecting cylinder (94) is a bolt, which may be a screw, a dog-nose screw, a pin or any other device that will movably secure the arm (102) to the actuator (382). In a still further embodiment, the connecting cylinder (94) is threadedly connected to the actuator (382) and the arm (102). Further, in yet another embodiment of the invention, the connecting cylinder (94) is threadedly connected to a nut (89).

[0075] As shown in Figure 18, a further embodiment of the invention includes a plurality of mounting holes (44) positioned for connecting the bonnet (125) to the body (344). In a still further embodiment of the invention, the body (344) includes a plurality of receptacle cylinder holes (45) positioned for connecting the body (344) to the bonnet (125). In order to fill the plurality of mounting holes (44) and the plurality of receptacle cylinder holes (45), a further

embodiment of the invention, as shown in Figure 40, includes a plurality of mounting cylinders (34) positioned to connect the bonnet (125) to the body (344).

[0076] In a further embodiment, the plurality of mounting cylinders (34) are connected to the body (344) and the bonnet (125). In a further and alternative embodiment, the plurality of mounting cylinders (34) are threadedly connected to the body (344) and the bonnet (125). Further alternative embodiments of the invention include the plurality of mounting cylinders (34) being a plurality of bolts or a plurality of pins.

[0077] In another embodiment of the invention, the bonnet (125) further includes a stop (50). The stop (50) limits the rotary movement (501) of the selective interrupter (100). As such, in one embodiment, the stop (50) is a raised stop (51), which prevents the actuator (382) from turning beyond a certain maximum. In turn, this limits the rotation of the selective interrupter (100). The raised stop (51) prevents the user from endlessly actuating the selective interrupter (100), and thereby, the raised stop (51) adds safety and ease of use to the design of the valve (346).

[0078] In a further embodiment, as shown in Figure 19a, a friction member (30) is located between the bonnet (125) and the body (344). An example of such a friction member (30) is an o-ring (31). But a friction member (30) is not necessary if the tolerance (123) is sufficiently small so that the bonnet (125) effectively seals the body (344) once the bonnet (125) is connected to the body (344).

[0079] As shown in Figure 19b, a further embodiment of the invention includes the actuator (382) having a pressure pin (11). A still further embodiment of the invention, as shown in Figure 19a, includes the bonnet (125) also having at least two pressure pinholes (12a, 12b) for sliding the pressure pin (11) into a locked position (9) on the bonnet (125). Depending within which of the at least two pressure pinholes (12a, 12b) that the pressure pin (11) is located, the flow arrangement (110) either includes the instrument (302) or the dummy load (328).

[0080] In a further embodiment of the invention, the actuator (382) includes a software program that will control the rotation of the selective interrupter (100) based on data input from various sensing devices within or external to the airplane. For example, the software program will determine the frequency, speed and degree to which the at least three apertures (376a, 376b, 376c) and the at least three body apertures (378a, 378b, 378c) should be open in order to maintain a balanced pressure system.

[0081] As seen in Figure 20, a further embodiment of the invention includes the body (344) having a lip (17). In a still further embodiment, the lip (17) includes a plurality of installation holes (71) that are positioned for installing the valve (346) into an aircraft instrument panel (108). In a still further embodiment, the lip (17) also includes a plurality of installation cylinders (73) that are positioned for installing the valve (346) into an aircraft instrument panel (108).

[0082] Turning now to Figure 21, a second aspect of the invention is seen — a system. The system (300) is for protecting a pneumatic-gyroscopic aircraft instrument (302), where the instrument (302) is driven by a driver source (304). The system (300) includes a means (310) for allowing a pneumatic flow (312) to the instrument (302) during flight, and a means (320) for selectively redirecting the pneumatic flow (312) to the instrument (302) without interrupting the pneumatic flow (312) of the driver source (304). The driver source (304) is a pressure source or a vacuum source.

[0083] In a further embodiment, as shown in Figure 22, the means (310) for allowing the pneumatic flow (312) to the instrument (302) comprises a means (326) for coupling, through a valve (346), the driver source (304) to the instrument (302). In a still further embodiment, the valve (346) includes a first body aperture (378a) of at least three body apertures (378a, 378b, 378c) coupled to the driver source (304) and a second body aperture (378b) of the at least three body apertures (378a, 378b, 378c) coupled to the instrument (302). The coupling, itself, is through the use of standard aircraft tubing or any other material that can suitably couple the valve to the instrument (302) and the driver source (304).

[0084] As shown in Figure 23, a further embodiment of the invention is a means (320) for selectively redirecting, without interrupting, the pneumatic flow (312) to include a means (326) for coupling, through a valve (346), the driver source (304) to a dummy load (328). In a still further embodiment of the invention, a first body aperture (378a) of at least three body apertures (378a, 378b, 378c) is coupled to the driver source (304) and a third body aperture (378c) of the at least three body apertures (378a, 378b, 378c) is coupled to the dummy load (328). Again, the coupling, itself, is through the use of standard aircraft tubing or any other material that can suitably couple the valve to the driver source (304) and to a dummy load (328).

[0085] As shown in Figure 24, a further embodiment of the invention is a means (320) for selectively redirecting, without interrupting, the pneumatic flow (312) to include a means (340) for moving a seat (342) that is located inside a body (344) of a valve (346). Further, the valve

(346) is coupled to the driver source (304), the instrument (302), and a dummy load (328). In a still further embodiment, as shown in Figure 25, the means (340) for moving the seat (342) includes a means (380) for moving an actuator (382) that is coupled to the seat (342). Further still, in yet another embodiment of the invention, as seen in Figure 26a, the means (380) for moving the actuator (382) includes a means (386) for driving the actuator (382). In a further embodiment, a means (386) for driving the actuator (382) is a motor (500) with a geared drive shaft (502) in contact with gearing on the arm (102) that act in tandem to move the seat (342).

[0086] In a further embodiment of the invention, as shown in Figure 26b, the means (380) for moving the actuator (382) includes a means (388) for turning the actuator (382). In a further embodiment, a means (388) for turning the actuator (382) is screwed gearing (504) coupled to the actuator (382). The screwed gearing (504) includes a drive shaft (6), which is connected to the bonnet (125), and works in tandem with screwed gearing on the arm (102).

[0087] In a further embodiment of the invention, as shown in Figure 26c, the means (380) for moving the actuator (382) includes a means (390) for sliding the actuator (382). In a still further embodiment, a means (390) for sliding the actuator (382) comprises keyed gearing (506) coupled to the actuator (382). The keyed gearing (506) includes a drive shaft (6), which is connected to the bonnet (125), and works in tandem with keyed gearing on the arm (102).

[0088] In a further embodiment, as shown in Figure 27, the means (380) for moving the actuator (382) includes a means (420) for limiting a rotary movement (501) of the seat (342). In a still further embodiment, a means (420) for limiting the rotary movement (501) comprises the actuator (382) contacting a stop (50). Contacting a stop (50) limits the range of motion for the actuator (382), which in turn, limits the range of motion for seat (342), and thereby, limits the number of rotations that the at least three apertures (376a, 376b, 376c) have in order to align with the at least three body apertures (378a, 378b, 378c) for redirecting the pneumatic flow (312) to the instrument (304) or the dummy load (328).

[0089] As shown in Figure 28a, a further embodiment of the invention includes a means (340) for moving the seat. The means for moving the seat (340) includes a means (392) for covering one body aperture (378a) of the at least three body apertures (378a, 378b, 378c) of the valve (346), thereby preventing a flow relationship (372) between the driver source (304) and the instrument (302). In preventing the flow relationship (372) between the driver source (304) and the instrument (302), a still further embodiment unfolds by the same movement of the seat. In

this further aspect of the embodiment, a means (340) for moving the seat also includes a means (394) for exposing another body aperture (378b) of the at least three body apertures (378a, 378b, 378c) of the valve (346), thereby allowing the flow relationship (372) between the driver source (304) and a dummy load (328).

[0090] As shown in Figure 29a, a further embodiment of the invention includes a means (340) for moving the seat. The means for moving the seat (340) includes a means (392) for covering one body aperture (378a) of the at least three body apertures (378a, 378b, 378c) of the valve (346), thereby preventing a flow relationship (372) between the driver source (304) and a dummy load (328). In preventing the flow relationship (372) between the driver source (304) and the dummy load (328), a still further embodiment unfolds by the same movement of the seat. In this further aspect of the embodiment, a means (340) for moving the seat also includes a means for exposing another body aperture (378b) of the at least three body apertures (378a, 378b, 378c) of the valve (346), thereby allowing the flow relationship (372) between the driver source (304) and the instrument (302).

[0091] As shown in Figure 28b, a further embodiment of the invention is the means (320) for selectively redirecting to include a means (398) for locking the valve (346) to prevent a flow relationship (372) between the driver source (304) and the instrument (302). In this manner, the flow relationship (372) exists between the driver source (304) and the dummy load (328). For example, as seen in Figures 19a and 19b, locking the valve (346) is accomplished by a pressure pin (11) extending from the actuator (382), and the pressure pin (11) locking into a pressure pinhole (12a or 12b) located on the bonnet (125) of the valve (346). Finally, in another embodiment of the invention, as shown in Figure 29b, the means (320) for selectively redirecting includes a means (398) for locking the valve (346) to prevent a flow relationship (372) between the dummy load (328) and the instrument (302). In this manner, the flow relationship (372) exists between the driver source (304) and the instrument (302).

[0092] Now turning to a third aspect of the invention, a method exists for protecting a pneumatic-gyroscopic aircraft instrument (302). The drawings for the system claims are referenced below for purposes of discussing the method claims. In discussing the method claims, it is understood that any reference to the system claim drawings refers to elucidation of the method claims.

[0093] In one embodiment, as illustrated in Figure 21, a method (200) for protecting a

pneumatic-gyroscopic aircraft instrument (302), where the instrument (302) is driven by a driver source (304), comprises allowing a pneumatic flow (312) to the instrument (302) during flight, and selectively redirecting, without interrupting, the pneumatic flow (312) of the driver source (304).

[0094] In a further embodiment, as shown in Figure 22, allowing the pneumatic flow (312) to the instrument (302) comprises coupling, through a valve (346), the driver source (304) to the instrument (302). In a still further embodiment, the valve (346) includes a first body aperture (378a) of at least three body apertures (378a, 378b, 378c) coupled to the driver source (304) and a second body aperture (378b) of the at least three body apertures (378a, 378b, 378c) coupled to the instrument (302). Coupling the valve to the instrument (302) and the driver source (304) is achieved through the use of standard aircraft tubing or any other suitable coupling material.

[0095] As shown in Figure 23, a further embodiment of the invention includes selectively redirecting, without interrupting, the pneumatic flow (312) by coupling, through a valve (346), the driver source (304) to a dummy load (328). In a still further embodiment of the invention, a first body aperture (378a) of at least three body apertures (378a, 378b, 378c) is coupled to the driver source (304) and a third body aperture (378c) of the at least three body apertures (378a, 378b, 378c) is coupled to the dummy load (328). Again, coupling the valve to the driver source (304) and the dummy load (328) is achieved through the use of standard aircraft tubing or any other suitable coupling material.

[0096] As shown in Figure 24, a further embodiment of the invention comprises selectively redirecting, without interrupting, the pneumatic flow (312) comprising moving a seat (342) that is located inside a body (344) of a valve (346). Further, the valve (346) is coupled to the driver source (304), the instrument (302), and a dummy load (328). In a still further embodiment, as shown in Figure 25, moving the seat (342) comprises moving an actuator (382) that is coupled to the seat (342). Further still, in yet another embodiment of the invention, as seen in Figure 26a, moving the actuator (382) comprises driving the actuator (382). In a further embodiment, driving the actuator (382) is accomplished by a motor (500) with a geared drive shaft (502) in contact with gearing on the arm (102) that act in tandem to move the seat (342).

[0097] In a further embodiment of the invention, as shown in Figure 26b, moving the actuator (382) comprises turning the actuator (382). In a further embodiment, turning the actuator (382) comprises using screwed gearing (504) that is coupled to the actuator (382). The screwed

gearing (504) includes a drive shaft (6), which is connected to the bonnet (125), and works in tandem with screwed gearing on the arm (102).

[0098] In a further embodiment of the invention, as shown in Figure 26c, moving the actuator (382) comprises sliding the actuator (382). In a still further embodiment, sliding the actuator (382) comprises using keyed gearing (506) that is coupled to the actuator (382). The keyed gearing (506) includes a drive shaft (6), which is connected to the bonnet (125), and works in tandem with keyed gearing on the arm (102).

[0099] In a further embodiment, as shown in Figure 27, moving the actuator (382) comprises limiting the rotary movement (501) of the seat (342). In a still further embodiment, limiting the rotary movement (501) includes the actuator (332) contacting a stop (50). Contacting a stop (50) limits the actuator's (382) range of motion, which in turn, limits the seat's (342) motion, and thereby, limits the number of rotations that the at least three apertures (376a, 376b, 376c) have in order to align with the at least three body apertures (378a, 378b, 378c) for permitting or restraining the pneumatic flow (312) in the course of redirecting the pneumatic flow (312).

[00100] As shown in Figure 28a, a further embodiment of the invention comprises moving the seat. Moving the seat (340) includes covering one body aperture (378a) of the at least three body apertures (378a, 378b, 378c) of the valve (346), which prevents a flow relationship (372) between the driver source (304) and the instrument (302). In preventing the flow relationship (372) between the driver source (304) and the instrument (302), a still further embodiment unfolds by the same movement of the seat (340). In this further aspect of the embodiment, moving the seat (304) also comprises exposing another body aperture (378b) of the at least three body apertures (378a, 378b, 378c) of the valve (346), which allows the flow relationship (372) between the driver source (304) and a dummy load (328) without interrupting the flow of the driver source (304).

[00101] As shown in Figure 29a, a further embodiment of the invention comprises moving the seat. Moving the seat (340) comprises covering one body aperture (378a) of the at least three body apertures (378a, 378b, 378c) of the valve (346), which prevents a flow relationship (372) between the driver source (304) and a dummy load (328). In preventing the flow relationship (372) between the driver source (304) and the dummy load (328), a still further embodiment unfolds by the same movement of the seat. In this further aspect of the embodiment, moving the seat also comprises exposing another body aperture (378b) of the at least three body apertures

(378a, 378b, 378c) of the valve (346), which allows the flow relationship (372) between the driver source (304) and the instrument (302).

[00102] As shown in Figure 28b, a further embodiment of the invention for selectively redirecting, without interrupting, the pneumatic flow (312) comprises locking the valve (346) to prevent a flow relationship (372) between the driver source (304) and the instrument (302). In this manner, the flow relationship (372) exists between the driver source (304) and the dummy load (328). Finally, in another embodiment of the invention, as shown in Figure 29b, the means (320) for selectively redirecting, without interrupting, the pneumatic flow (312) comprises locking the valve (346) to prevent a flow relationship (372) between the dummy load (328) and the driver source (304). In this manner, the flow relationship (372) exists between the driver source (304) and the instrument (302).

[00103] Accordingly, while various embodiments of the invention have been shown and described herein, modifications may be made by one skilled in the art without departing from the spirit and the teachings of the invention. The embodiments described here are exemplary only, and are not intended to be limiting. Many variations, combinations, and modifications of the invention disclosed herein are possible and are within the scope of the invention. The different teachings of the embodiments discussed herein may be employed separately or in any suitable combination to produce desired results. Accordingly, the scope of protection is not limited by the description set out above, but is defined by the claims which follow, that scope including all equivalents of the subject matter of the claims.